**Modeling Protocol for
Washington, Oregon, and Idaho:
Protocol for the Application of the CALPUFF Modeling System Pursuant
to the Best Available Retrofit Technology (BART) Regulation**

1. Introduction and Protocol Objective

1.1. *Background*

Under the Regional Haze Regulations, the U.S. Environmental Protection Agency (EPA) issued the final Guidelines for Best Available Retrofit Technology (BART) Determinations (July 6, 2005) (BART Guideline). According to the Regional Haze Rule, States are required to use these Guidelines for establishing BART emission limitations for fossil fuel fired power plants having a capacity in excess of 750 megawatts. The use of these guidelines is optional for States for establishing BART emission limitations for other BART eligible sources. However, according to EPA, the BART guidelines were designed to help States and others (1) identify those sources that must comply with the BART requirement, and (2) determine the level of control technology that represents BART for each source.

This protocol is a combined effort between Idaho Department of Environmental Quality (IDEQ), Oregon Department of Environmental Quality (ODEQ), and Washington Department of Ecology (WDOE) and adopts the BART Guidelines and addresses both the BART exemption modeling as well as the BART determination modeling. The three agencies are also collaborating on the development of a consistent three year meteorological dataset. The collaboration on the protocol and meteorological dataset helps to ensure consistency in the modeling and sharing the resources and workload.

1.2. *Objectives*

The protocol describes the modeling methodology that will be used for the following purposes:

- **BART Exemption modeling –** Evaluating whether a BART-eligible source is exempt from BART controls because it is not reasonably anticipated to cause or contribute to impairment of visibility in Class I areas; and
- **BART Determination modeling –** Quantifying the visibility improvements of BART control options.

The objectives of this protocol are to provide

- A stream-lined and consistent approach in determining which BART-eligible sources are subject to BART
- Clearly delineated modeling methodology
- A common CALMET/CALPUFF/POSTUTIL/CALPOST modeling configuration

2. Modeling Approach

2.1. Bart-Eligible Source List

Oregon, Washington, and Idaho are in the process of finalizing the lists of BART-eligible sources. Table 1 presents the BART-eligible lists, as of May 1, 2006. Sources may be added/removed as additional information is reviewed.

Table 1. BART-eligible sources.

Washington	Oregon	Idaho
Intalco Aluminum	Amalgamated Sugar	Amalgamated Sugar – Nampa
Conoco-Phillips	PGE Boardman	Amalgamated Sugar – Paul
Centralia Powerplant (TransAlta)	Boise Cascade	Amalgamated Sugar – Twin Falls
Longview Fibre	Fort James	J.R. Simplot Don Siding Plant
Weyerhaeuser – Longview	Pope & Talbot	Potlatch Pulp and Paper
BP Cherry Point	Weyerhaeuser	Monsanto
Tesoro NW	PGE Beaver	NuWest (Agrium)
Lafarge	Georgia Pacific	
Georgia Pacific (Fort James) Camas	Smurfit	
Port Townsend Paper	SFPP	
Simpson Tacoma Kraft		
Shell (Puget Sound Refining Co)		
Graymont Western		
Alcoa-Wenatchee		
Columbia		

2.2. Class I Areas

The mandatory Class I federal areas in ID, OR and WA as well as neighboring states that could be impacted by BART-eligible sources are presented in Appendix A. Figure A-1 graphically presents the BART-eligible source locations with respect to the Class I areas.

All federally mandatory Class I areas within 300 kilometers (km) of a BART-eligible source will be included in the BART exemption modeling analysis. If the 300 km extends into a neighboring state, visibility impairment shall also be quantified at those Class I areas. Furthermore, if it lies within the 300-km radius, visibility impairment at the Columbia River Gorge Scenic Area will also be quantified.

2.3. Pollutants to Consider

The BART Guideline specifies that SO_2, NO_x and direct particulate matter (PM) emissions, including both PM_{10} and $PM_{2.5}$ should be included for both the BART exemption and BART determination modeling analyses.

The BART Guideline also discusses the inclusion of VOC, ammonia and ammonia compounds as visibility impairing pollutants. These pollutants will be included in the BART analysis if it is determined that they are reasonably anticipated to cause or contribute to visibility impairment. This will be determined on a case-by-case basis.

2.4. *Emissions and Stack Data*

The BART Guideline states that "*the emission estimates used in the models are intended to reflect steady-state operating conditions during periods of high capacity utilization.*" These emissions should not generally include start-up, shutdown, or malfunction emissions. The BART Guideline recommends that States use the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled. The meteorological period is 2003 – 2005.

Depending on the availability of emissions data, the following emissions information (listed in order of priority) should be used with CALPUFF for BART exemption modeling:

- 24-hour average actual emission rate from the highest emitting day within the modeling period (2003 – 2005) (preferred)
- Allowable emissions (maximum 24-hour allowable)

If plant-wide emissions for a SO2, NOx, and PM10 are less than the significant emission rate (SER), emissions of that pollutant will not be included in the BART exemption modeling. However, if plant-wide emissions exceed the SERs for these pollutants, then all emissions of that pollutant from individual emission units (EUs) will be evaluated even if emissions are below the SER for an individual EU.

Due to the complexity of estimating visibility impairment from a single VOC source, VOC exemption analyses will be conducted on a case-by-case basis. VOC emissions will be included in the BART exemption analysis if they exceed 250 tpy. If the speciation of the VOC emissions is known, then only emissions of those VOCs with more than six carbon atoms per gas molecule will be evaluated. If speciation is not known, it will be conservatively assumed that 50% of the gas species within total VOC emissions from a facility have greater than six carbon atoms. The greater-than-six-carbon VOC gases will be modeled as organic carbon (OC) emissions in CALPUFF for evaluation of visibility impairment.

2.5. *Natural Background*

The natural visibility background will be Class I specific. The natural background used for the BART exemption modeling is taken from the EPA's "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule" (EPA 2003). Appendix B lists the natural visibility conditions for the Class I areas listed in Appendix A.

2.6. *Visibility Calculation*

The CALPUFF modeling techniques presented in this protocol will provide ground level concentrations of visibility impairing pollutants. The concentration estimates from CALPUFF are used with the current FLAG equation to calculate the extinction coefficient, as shown below.

$b_{ext} = 3\ f(RH)\ [(NH_4)_2SO_4] + 3\ f(RH)\ [NH_4NO_3] + 4[OC] + 1[Soil] + 0.6[Coarse\ Mass] + 10[EC] + b_{Ray}$

As described in the IWAQM Phase 2 Report, the change in visibility, for the BART exemption analysis, is compared against background conditions. The delta-deciview, Δdv, value is calculated from the source's contribution to extinction, $b_{ext\ (source)}$, and background extinction, $b_{ext(bkg)}$, as follows:

$$\Delta dv = 10\ ln\ (b_{ext(bkg)} + b_{ext\ (source)}) / b_{ext(bkg)}\ )$$

This calculation is completed on a day-by-day, receptor-by-receptor basis.

2.7. *Model Execution*

2.7.1. BART Exemption Analysis

The BART exemption modeling determines which BART-eligible sources are reasonably anticipated to cause or contribute to visibility impairment at any Class I area. This protocol adopts Option 1 in Section III of the BART Guidelines. This option is the Individual Source Attribution Approach. With this approach, each BART-eligible source is modeled separately and the impact on visibility impairment on any Class I area is determined. However, this protocol also allows the state or other authority to include all BART-eligible sources in a single analysis and determine whether or not all sources together are exempt from BART if the total impact on visibility impairment is below the "contribute" threshold.

For each BART-eligible source, the CALPUFF modeling will predict a level of visibility impairment at each Class I area for each day of the three years of meteorology. The highest levels of impairment above natural backround over this period will be compared to a threshold level,. Sources, or in some cases, groups of sources, that exceed the threshold will be considered Subject to BART. Sources with modeled impairment below the threshold will be exempt and excused from further analyses.

The exemption analysis proceeds in four steps.

1) Determining the level of visibility impairment using the visibility calculation.
2) Determining the method to estimate natural background at each Class I area, and calculating the increase in visibility impairment relative to that background in deciviews.
3) Ordering the levels of impairment from high to low and selecting a value that represents the visibility impairment for each source at each Class I area.
4) Comparing the representative impairment value of each source to a "contribute"

threshold to determine significance.

Two approaches have been proposed to determine the representative impairment value for each source (steps 2 and 3) for comparison to a visibility threshold. Results from both approaches will be determined.

- Primary Approach:
  The 98th percentile of the increase in Haze Index (HI) from a BART-eligible source or sources relative to Natural Background defined as the 20% best visibility days for each Class I area.
- Alternative Approach:
  The 100th percentile of the increase in HI relative to Natural Background defined as the annual average of visibility days for each Class I area.

For determining the visibility threshold, the recommendations in the BART Guideline are followed to assess whether a BART-eligible source is reasonably anticipated to cause or contribute to any visibility impairment in a Class I area. According to the BART Guideline:

"A single source that is responsible for a 1.0 deciview change or more should be considered to "cause" visibility impairment; a source that causes less than a 1.0 deciview change may still contribute to visibility impairment and thus be subject to BART… As a general matter, any threshold that you used for determining whether a source "contributes" to visibility impairment should not be higher than 0.5 deciviews.

In setting a threshold for "contribution," you should consider the number of emissions sources affecting the Class I areas at issue and the magnitude of the individual sources' impacts. In general, a larger number of sources causing impacts in a Class I area may warrant a lower contribution threshold. States remain free to use a threshold lower than 0.5 deciviews if they conclude that the location of a large number of BART-eligible sources within the State and in proximity to a Class I area justify this approach."

This protocol adopts the recommendation in the BART Guideline and will use the 0.5 deciview as the "contribute" threshold. If a single source causes a 0.5 deciview or greater change from natural background, then that source is determined to be reasonably anticipated to contribute to any visibility impairment in a Class I area.

In addition, as recommended by the BART Guideline, if multiple BART-eligible sources impact a given Class I area on the same day, then a lower contribution threshold may be considered. This protocol addresses this issue using the following process. After all BART-eligible sources have completed their individual BART exemption modeling, the modeled visibility impairment from all sources will be aggregated for each Class I area receptor for each day. If this total for any receptor exceeds the 0.5 deciview contribute threshold, all sources responsible for visibility impairment at that receptor are graded according to their level of contribution for that day. In this cumulative analysis, sources that are considered significant contributors will be further evaluated according to the magnitude, frequency, duration of impairment, and other factors that affect visibility. As a result, a lower contribution threshold may be considered for each of these cumulative sources. This cumulative approach follows the recommendations for sources subject to PSD analyses given in the FLAG Phase I Final Report (Dec. 2000) by the Federal Land Managers AQRV Group. After this evaluation, a determination will be made if a source contributes to visibility impairment and is subject to BART.

2.7.2. BART Determination Analysis

The BART Determination analysis determines the degree of visibility improvement for each control option. The BART Guideline states:

"Assess the visibility improvement based on the modeled change in visibility impacts for the pre-control and post-control emission scenarios. You have the flexibility to assess visibility improvement due to BART controls by one or more methods. You may consider the frequency, magnitude, and duration components of impairment."

In order to quantify the degree of visibility improvement due to BART controls, the modeling system is executed in the same manner as for the BART exemption analysis. Model execution and results are needed for both pre-BART control and post-BART control scenarios, to allow for comparison of CALPOST delta-deciview predictions for both scenarios. The only difference between the modeling runs will be the modifications to the CALPUFF inputs associated with control devices (emissions, stack parameters).

2.7.3. Implementing BART Modeling Analysis

Each state will implement the BART analysis separately, as follows:

- Idaho – DEQ will perform both the BART exemption and BART determination modeling, working closely with the facilities and providing the facilities with the modeling analysis if they want to perform the analysis as well.

- Oregon – DEQ will perform the BART exemption analysis and the individual BART-subject facilities will perform the BART determination analysis.

- Washington – EPA Region 10 is responsible for the BART analysis since they are responsible for writing a Federal Implementation Plan (FIP) for the state of Washington.

3. Visibility Modeling System

In general, the BART exemption modeling using the CALPUFF suite of programs will follow the procedures and recommendations outlined in two documents: the IWAQM (Interagency

Workgroup on Air Quality Models) and the FLAG (Federal Land Managers Air Quality Related Values Workgroup) reports. Exceptions to these procedures are explicitly described in the appropriate sections below. Tables listing the modeling parameters for each CALPUFF module are located in the Appendicies.

The specific CALPUFF programs and their version numbers that will be used in both the Exemption modeling and Determination modeling (control evaluation) are presented in Table 2.

The CALMET meteorological domain, as described below, covers the full three-state area. The computational domains, which will be unique for each source or group of sources undergoing modeling, will be a subset of the meteorological domain. As a result, a consistent meteorological dataset will be used in all analyses, but the computational domains will be tailored to suit the modeling requirements for each individual source and the Class I areas within a radius of 300 km.

Table 2. CALPUFF Modeling System

Program	Version	Level
CALMET	6.0	060331
CALPUFF	6.0	060331
POSTUTIL	6.0	
CALPOST	6.0	

3.1. *CALMET*

The dispersion modeling will use CALMET windfields for the three-year period 2003-2005. These windfields will cover the three-state area of Washington, Oregon, and Idaho, and also extend into adjacent states sufficiently to encompass all Class I areas within 300 km of any BART-eligible facility included in this analysis (Figure 1). As part of the three-state collaboration on a BART protocol, it was decided to support the development of a consistent meteorological dataset for use in both the BART exemption and determination analyses. Therefore, the states contracted with a consulting firm, Geomatrix, to provide this set of meteorological data for use in CALPUFF for determining whether a BART-eligible source is reasonably anticipated to cause or contribute to haze in a Federal Class I area.

One of the deliverables of that contract is a final CALMET modeling protocol that provides details on the methodology used to develop the datasets. Therefore, this BART modeling protocol only summarizes the development of the CALMET dataset. For additional detail, the reader is referred to the "*Modeling Protocol for BART CALMET Datasets.*"

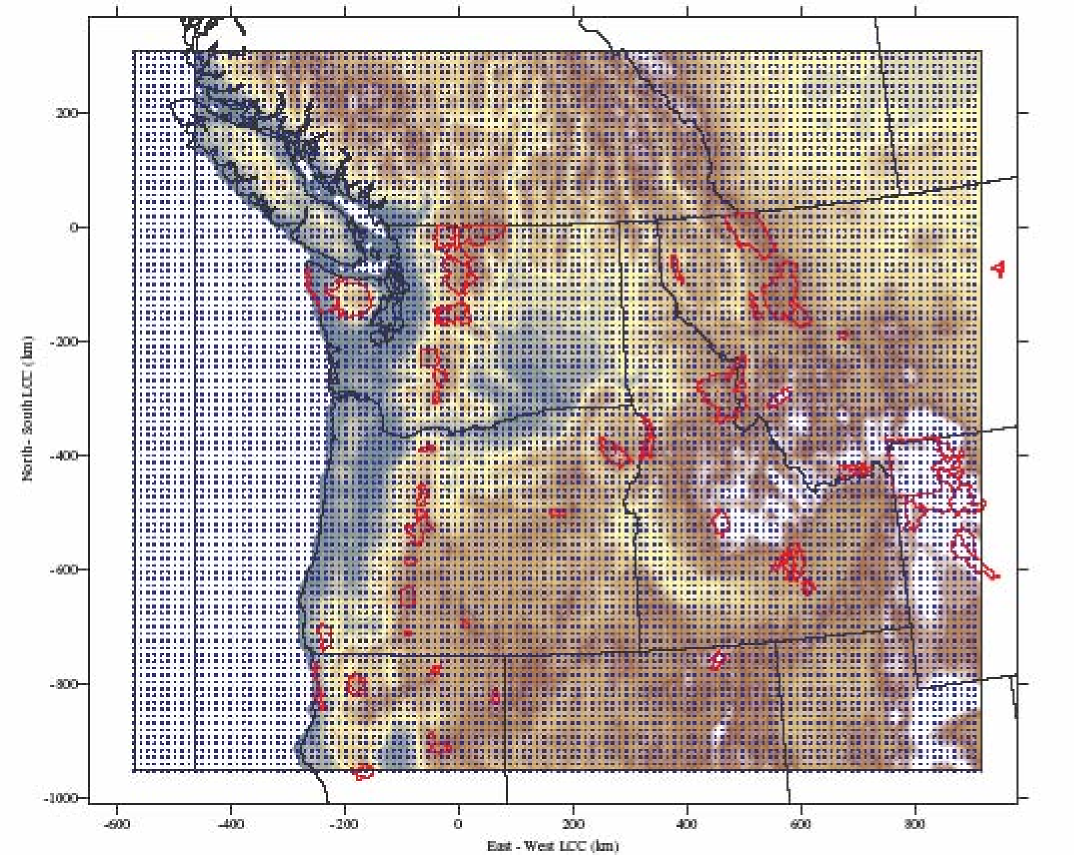

Figure 1. CALMET Meteorological Domain.

3.1.1. Meteorological Data

3.1.1.1. Mesoscale Model Data

It was the judgement of ID, OR, WA and EPA Region 10 that the use of three years of MM5 data developed by Western Regional Air Partnership (WRAP) would not adequately capture the meteorology in the Pacific Northwest. WRAP had run MM5 using 36-km and 12-km grids. The states and EPA Region 10 preferred a 4-km grid as it would more adequately capture the meteorology and the influences of complex terrain that characterizes the Region 10 area. Furthermore, WRAP had selected some physic options that are more appropriate for the dry southwest and not the wet northwest.

As a result, the three states contracted a consulting firm (Geomatrix) to process calendar year 2003 to 2005 forecast 12-km MM5 output files archived at the University of Washington. The 12-km MM5 domain includes all of Idaho, Oregon and Washington. Portions of Montana, Wyoming, Utah, Nevada and California are also included in the domain so that BART-eligible sources near these state borders which could have an impact at Class I areas outside of Region 10 are considered in the analysis.

The MM5 data will be evaluated for model performance. CALMET Version 6, including a new over water algorithm will be used to interpolate the 12-km data down to 4-km for the entire domain. Similar to the MM5 data, the CALMET outputs will also be evaluated to determine the model performance of the CALMET windfields The statistical benchmarks listed in the WRAP Draft Final Report Annual 2002 MM5 Meteorological Modeling to Support Regional Haze Modeling of the Western United States (ENVIRON and UCR, 2005) will serve as guide for the acceptability of the MM5 data and CALMET output.

CALMET allows the user to adjust the MM5 wind fields in varying degree by the introduction of observational data, including surface, overwater, and upper air data (using the so-called NOOBS parameter). ID, OR and WA have determined that the observed cloud cover should be used, but that observed surface and upper air winds should not be included in CALMET as they locally distort the MM5 wind fields and have no significant effect on long range transport. As a result, the three states have judged that the MM5 simulations more than adequately characterize the regional wind patterns. It should also be noted that CALMET will use the finer scale landuse and digital elevation model (DEM) data to interpolate the MM5 winds down to 4-km, which should improve the wind flow patterns in complex terrain within the modeling domain.

3.1.2. CALMET Control File Settings

These CALMET windfields will be used by all BART-eligible sources within the three states for both BART exemption and BART determination modeling. The windfields will be provided by Geomatrix using CALMET Version 6. Details of the parameter settings in CALMET are provided in Appendix D, however, the major assumptions are summarized below.

1) The initial guess fields will use the 12-km MM5 outputs, forecast hours 12 – 23 from every 00Z and 12Z initialization, taken from the University of Washington (UW) archives, for the three years, January 2002 – December, 2004.

2) Two 3-year data sets, at 12-km and 4 km resolution, will be developed using CALMET. The BART exemption and determination modeling will utilize the windfields at 4 km resolution.

3) The meteorological data will be evaluated in two stages using the extensive database of surface observations maintained by UW, and the METSTAT software program. First the MM5 12-km data will be evaluated prior to running CALMM5, and secondly, the windfields generated by CALMET will be evaluated.

4) There will be 10 vertical layers with face heights of 0, 20, 40, 65, 120, 200, 400, 700, 1200, 2200, and 4000 meters.

5) CALMET will be run using NOOBS = 1. Upper air, precipitation, and relative humidity data will be taken from MM5.

6) The surface wind observations will be ignored by setting the relative weight of surface winds (R1 = 1.0E-06) to essentially zero. The only surface observation data that will be

effectively used in CALMET is cloud cover. This is essentially a no-observation approach. This method is specified in this protocol because previous modeling in the Pacific Northwest shows that the radius of influence of a typical surface wind observation must be set at a small number because of the presence of local topographic features. As a result, the adjustment to or distortion of wind fields by surface observations is extremely localized, on the order of 10-15 km, and has no effect on long range transport to Class I areas.

7) Precipitation data from MM5, so MM5NPSTA = -1.

8) No weighting of surface and upper air observations, and BIAS = 0, and ICALM = 0

9) The terrain scale factor TERRAD = 12.

10) MM5 over water land use scheme will be used and the CALMET over water landuse disabled by setting JWAT1 and 2 =100.

11) Landuse and terrain data will be developed using the North American 30 arc second data.

3.2. CALPUFF

The CALPUFF modeling will use Version 6. This protocol generallly follows the recommendation of the IWAQM and FLAG reports. Details of the parameter settings in CALPUFF are provided in Appendix E, however the major features are summarized below:

1) The three-year CALMET input files will be developed by Geomatrix and be provided as input-ready to CALPUFF.

2) The BART exemption modeling will examine the visibility impairment on Class I areas within 300 km of each single source. Where BART-eligible sources are grouped or where their emissions could collectively impair visibility in a Class I area, the exemption modeling will also group these sources in order to examine their cumulative impact. The computational modeling domain will be sufficient to include all Class I areas within a 300 km radius of a source or sources.

3) Pasquill-Gifford Dispersion coefficients will be used.

4) MESOPUFF-II chemistry algorithm will be used.

5) Building downwash will be ignored

3.2.1. Emissions

Section 2.4 above presents the emissions and stack data that is required from the facilities. This section only discusses the emissions estimates needed in CALPUFF.

Primary emission species modeled will include SO2, SO4, NOx, HNO3, and NO2. Emissions of H2SO4 should be included, if known, and used for estimation of SO4 emissions.

The particulate (PM) species will be treated as follows:

- Particulate will be speciated using profiles as shown in Appendix F, as recommended by the NPS and USFS (NPS, 2005), or by specific profiles that may be proposed by industry. Particulate species will include both the filterable and condensable fractions:

  Filterable.
    Elemental Carbon (EC) (<2.5 µm)
    PM Fine (SOIL) (<2.5 µm)
    PM Coarse (PMC) (2.5 – 10 µm)
  Condensable.
    Secondary Organic Aerosol (OC)
    Inorganic Aerosol (SO4)
    Non-SO4 inorganic aerosol

- The condensable fraction will be treated as primary emissions in the CALPUFF input file.

- Particulate will be categorized by size fraction as follows:
  - <0.625 µm
  - 0.625-1.0 µm
  - 1.0-1.25 µm
  - 1.25-2.5 µm,
  - 2.5-6.0 µm
  - 6-10 µm aerodynamic diameters

3.2.2. Ozone Background

Ozone background will be 40 ppb for October through May and 80 ppb for May through September.

3.2.3. Ammonia Background

Ammonia background will be 17 ppb, which is the value based on measurements made in 1996 – 1997 at Abbotsford in Frazier River Valley of British Columbia. This value has been commonly used as background for Prevention of Significant Deterioration modeling in the Pacific NW, and will ensure that for BART exemption modeling, conditions are not ammonia limited.

3.2.4. Receptor Locations

Predicted visibility impacts will be computed at two sets of receptors; a set of receptor locations for the Class I Areas within the domain which are available for download from the National Park Service Web site http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm, and on a 12 km mesh over the entire modeling domain to aid in model evaluation. Elevations for the grid points should be taken from the same data set used to define the 4 km topography in the CALMET modeling. Receptor points for the Columbia River Gorge Scenic Area will be provided by Oregon and Washington.

3.3. CALPOST and VISIBILITY POST-PROCESSING

The following assumptions will be used in CALPOST and POSTUTIL to calculate the visibility impairment.

1) For the visibility calculation, Method 6 will be employed. This method uses monthly average Relative Humidity and f(RH) values for each Class I area as provided in Appendix B, which are taken from the EPA Guidance for Regional Haze analysis (EPA 2003a, b).

2) Particulate species for the visibility analysis will be SO4, NO3, EC, OC, SOIL, and PMC

3) Since the ammonia background is set at 17 ppb, the ammonia limiting method in POSTUTIL will not be used.

4) Natural Background extinction calculations will use both the 20% Best Days and the Annual Average for each Class I area in the three-state region. The Annual Average extinction coefficients are the EPA default Western U.S. coefficients (EPA 2003). The extinction coefficients for the 20% Best Days have been calculated following in general the approach taken in the Montana BART modeling protocol. This procedure uses the Haze Index (HI) in deciviews at the 10th percentile (average of the 20% best days) and an activity factor that is calculated for each Class I area. Tables providing the monthly f(RH), Annual Average and 20% Best Days coefficients are provided in Appendix B, and are based on data from EPA (2003). For the exemption modeling, the Rayleigh scattering value will be 10 Mm-1 for all Class I areas.

5) Both the maximum visibility impairment (100th percentile) as well as the 98th percentile value will be calculated for all BART-eligible sources at each mandatory Class I area and the Columbia River Gorge. The 98th percentile value will be determined in the following two ways:

   - The 8th highest daily value for each meteorological year modeled
   - The 22nd highest daily value for all 3 meteorological years combined

Both methods will be used and the highest value of the two will be compared to the contribution threshold ($\Delta dv \geq 0.5$ dv). If there are more than 7 days with values greater than the contribution threshold for any meteorological year for any Class I areas for any one year, or more than 22 days in three years, then the source is considered Subject-to-BART.

6) The contribution threshold has the implied level of precision equal to the level of precision report by CALPOST. Therefore, the 98th percentile value will be reported to three decimal places.

4. Interpretation of Results

The visibility impairment analysis in the BART exemption modeling will look at the results of two approaches.

- The 98th percentile of the increase in Haze Index (HI) from a BART-eligible source or sources relative to Natural Background defined as the 20% best visibility days for each Class I area. This approach will be the primary method for the exemption analysis in the Region 10 states, and is also the basis for exemption modeling in the VISTAS, Colorado, and other regional and state protocols.
- The 100th percentile of the increase in HI relative to Natural Background defined as the annual average of visibility days for each Class I area.

The CALMET datasets being developed are using a non-Guideline approach. The Region 10 states have determined that it is more appropriate to only use the cloud cover from the surface observations (NOOBS option). The FLMs have determined that if this NOOBS option is used then the maximum value (100%tile) from the analysis should be used to compare to the contribution threshold. The FLMs state that they are not confident that the model won't underpredict the visibility impairment using the NOOBS option (EPA 2006a, 2006b, 2006c). The states also have the option of using the annual average natural background or the 20% best days natural background.

In order to ensure that the estimates of visibility impairment would not be biased towards underprediction, it was determined that the 98 percentile will be compared to the 20% best visibility days. However, the annual average natural background can be used when strictly following the FLMs recommendation and using the 100 percentile from the model.

5. References

ENVIRON and UCR. 2005. Draft Final Report Annual 2002 MM5 Meteorological Modeling to Support Regional Haze Modeling of the Western United States. Available at http://pah.cert.ucr.edu/aqm/308/reports/mm5/DrftFnl_2002MM5_FinalWRAP_Eval.pdf.

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EPA 2006a. Conference call with Fish and Wildlife, and the states of ID, OR and WA. January 17, 2006.

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EPA. 2006c. Conference call with the Fish and Wildlife, and the states of ID, OR and WA. January 20, 2006.

National Park Service (NPS). 2005. Email communication from Don Shepherd of the NPS to Michael Kiss Regarding PM Speciation. November 20, 2005.

VISTAS (Visibility Improvement State and Tribal Association of the Southeast). 2005. Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART). Available at http://www.vistas-sesarm.org/BART/VISTASBARTModelingProtocol_Dec222005.pdf. December 22.

Appendix A

Mandatory Class I Federal Areas

and

Columbia River Gorge Scenic Area

Figure A-1

Map of BART-Eligible Sources and Class I Areas

To be Posted on Idaho DEQ's Regional Haze BART Website

http://www.deq.idaho.gov/air/prog_issues/pollutants/haze_bart.cfm.

Table 1. Federal Mandatory Class I Areas.

Class I Area	Federal Land Manager
Idaho	
Craters of the Moon National Monument	Park Service
Hells Canyon Wilderness	Forest Service
Sawtooth Wilderness	Forest Service
Selway-Bitterroot Wilderness	Forest Service
Yellowstone National Park	Park Service
Oregon	
Crater Lake National Park	Park Service
Diamond Peak Wilderness	Forest Service
Eagle Cap Wilderness	Forest Service
Gearhart Mountain Wilderness	Forest Service
Hells Canyon Wilderness	Forest Service
Kalmiopsis Wilderness	Forest Service
Three Sisters Wilderness	Forest Service
Mount Hood Wilderness	Forest Service
Mount Jefferson Wilderness	Forest Service
Mount Washington Wilderness	Forest Service
Mountain Lakes Wilderness	Forest Service
Strawberry Mountain Wilderness	Forest Service
Washington	
Alpine Lakes Wilderness	Forest Service
Goat Rocks Wilderness	Forest Service
Glacier Peak Wilderness	Forest Service
Mount Adams Wilderness	Forest Service
Mount Ranier National Park	Park Service
North Cascades National Park	Park Service
Olympic National Park	Park Service
Pasayten Wilderness	Forest Service
Neighboring States	
Anaconda-Pintler Wilderness (MT)	Forest Service
Cabinet Mountains Wilderness (MT)	Forest Service
Missions Mountain Wilderness (MT)	Forest Service
Red Rock Lakes Refuge (MT)	Fish & Wildlife Service
Bridger Wilderness (WY)	Forest Service
Glacier National Park (WY)	Park Service
Grand Teton National Park (WY)	Park Service
Lassen Volcanic National Park (CA)	Park Service
Lava Beds National Monument (CA)	Park Service
Marble Mountain Wilderness (CA)	Forest Service
Redwood National Park (CA)	Park Service
South Warner Wilderness (CA)	Forest Service
Jarbridge Wilderness (NV)	Forest Service

Appendix B

Natural Visibility Background

and

Monthly Relative Humidity f(RH)

Adjustment to speciated particulate (Western States) to reflect Annual Avg and 20% Best Visibility Days conditions

Monthly f(RH) are from *Appendix A of Guidance for Estimating Natural Visibility Conditions Under the RHR (Sept. 2003)*.

Background extinction coefficients (20% Best Days) have been calculated using Annual Avg bext, Best 20% bext, and activity factors.

		CALPOST Input Group 2												CALPOST Input Group 2						CALPOST Input Group 2					
		Monthly extinction coefficients for hygroscopic species (RHFAC)												Background extinction coefficients (20% Best Days)						Background extinction coefficients (Annual Avg)					
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	BKSO4	BKNO3	BKPMC	BKOC	SOIL	BKEC	BKSO4	BKNO3	BKPMC	BKOC	SOIL	BKEC
Class I Area	**State**	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	f(RH)	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
CaribouWilderness	CA	3.69	3.13	2.83	2.45	2.37	2.17	2.07	2.13	2.20	2.38	3.01	3.41	0.048	0.040	1.20	0.188	0.200	0.008	0.120	0.100	3.00	0.470	0.500	0.020
LassenVolcanic	CA	3.81	3.19	2.91	2.53	2.42	2.19	2.09	2.14	2.23	2.43	3.13	3.53	0.048	0.040	1.21	0.189	0.201	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Lava Beds NP	CA	3.98	3.36	3.07	2.70	2.62	2.43	2.31	2.34	2.42	2.72	3.52	3.81	0.050	0.042	1.26	0.197	0.210	0.008	0.120	0.100	3.00	0.470	0.500	0.020
MarbleMountain	CA	4.44	3.79	3.74	3.33	3.37	3.24	3.18	3.19	3.24	3.37	4.12	4.15	0.052	0.043	1.30	0.204	0.217	0.009	0.120	0.100	3.00	0.470	0.500	0.020
RedwoodNP	CA	4.42	3.91	4.56	3.91	4.50	4.70	4.86	4.72	4.31	3.66	3.81	3.40	0.054	0.045	1.34	0.210	0.224	0.009	0.120	0.100	3.00	0.470	0.500	0.020
SouthWarner	CA	3.62	3.08	2.72	2.35	2.29	2.12	1.90	1.92	1.97	2.30	3.05	3.44	0.048	0.040	1.21	0.190	0.202	0.008	0.120	0.100	3.00	0.470	0.500	0.020
ThousandLakes	CA	3.81	3.19	2.91	2.53	2.42	2.19	2.09	2.14	2.23	2.43	3.13	3.53	0.048	0.040	1.21	0.190	0.202	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Yolla Bolly Middle Eel Wilderness	CA	3.95	3.35	3.14	2.76	2.68	2.47	2.44	2.50	2.56	2.70	3.31	3.62	0.049	0.041	1.24	0.194	0.206	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Craters of the Moon	ID	3.13	2.74	2.28	2.02	2.01	1.81	1.43	1.42	1.57	1.97	2.77	3.04	0.046	0.038	1.15	0.180	0.192	0.008	0.120	0.100	3.00	0.470	0.500	0.020
HellsCanyon	ID	3.70	3.12	2.51	2.17	2.12	2.00	1.63	1.58	1.79	2.41	3.45	3.87	0.048	0.040	1.21	0.190	0.202	0.008	0.120	0.100	3.00	0.470	0.500	0.020
SawtoothWilderness	ID	3.34	2.87	2.32	2.01	2.00	1.84	1.43	1.40	1.50	1.96	2.94	3.31	0.046	0.039	1.16	0.182	0.193	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Selway-BitterrootWilderness	ID	3.50	3.02	2.59	2.34	2.36	2.31	1.93	1.86	2.09	2.55	3.30	3.50	0.048	0.040	1.21	0.190	0.202	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Anaconda-PintlerWilderness	MT	3.32	2.88	2.54	2.35	2.36	2.31	1.96	1.88	2.10	2.52	3.15	3.29	0.048	0.040	1.20	0.188	0.200	0.008	0.120	0.100	3.00	0.470	0.500	0.020
BobMarshall	MT	3.57	3.10	2.77	2.59	2.66	2.70	2.34	2.23	2.58	2.92	3.47	3.54	0.049	0.041	1.22	0.191	0.203	0.008	0.120	0.100	3.00	0.470	0.500	0.020
CabinetMountains	MT	3.81	3.27	2.85	2.61	2.66	2.68	2.30	2.18	2.56	2.98	3.70	3.86	0.050	0.041	1.24	0.195	0.207	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Gates of the Mountain	MT	2.89	2.57	2.42	2.30	2.30	2.27	2.03	1.94	2.12	2.41	2.75	2.81	0.047	0.039	1.18	0.185	0.197	0.008	0.120	0.100	3.00	0.470	0.500	0.020
GlacierNP	MT	4.01	3.47	3.18	3.06	3.24	3.39	2.76	2.60	3.19	3.45	3.82	3.89	0.051	0.043	1.28	0.200	0.213	0.009	0.120	0.100	3.00	0.470	0.500	0.020
MissionMountain	MT	3.60	3.13	2.73	2.52	2.60	2.62	2.27	2.19	2.50	2.87	3.51	3.59	0.049	0.041	1.23	0.193	0.205	0.008	0.120	0.100	3.00	0.470	0.500	0.020
RedRock Lakes	MT	2.73	2.46	2.28	2.12	2.10	1.91	1.67	1.58	1.77	2.07	2.56	2.68	0.046	0.039	1.16	0.181	0.193	0.008	0.120	0.100	3.00	0.470	0.500	0.020
ScapegoatWilderness	MT	3.19	2.81	2.57	2.43	2.45	2.44	2.14	2.04	2.28	2.61	3.08	3.14	0.048	0.040	1.20	0.188	0.200	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Crater Lake NP	OR	4.57	3.92	3.68	3.36	3.22	2.99	2.84	2.87	3.05	3.59	4.57	4.56	0.053	0.044	1.32	0.206	0.219	0.009	0.120	0.100	3.00	0.470	0.500	0.020
DiamondPeak	OR	4.52	3.96	3.64	3.66	3.16	3.12	2.90	2.93	3.05	3.67	4.55	4.57	0.053	0.044	1.33	0.208	0.222	0.009	0.120	0.100	3.00	0.470	0.500	0.020
Eagle Cap	OR	3.77	3.16	2.47	2.10	2.04	1.87	1.61	1.56	1.61	2.25	3.44	3.97	0.049	0.041	1.22	0.191	0.203	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Gearhart Mountain	OR	3.96	3.38	3.06	2.75	2.65	2.48	2.28	2.30	2.38	2.84	3.65	3.84	0.050	0.042	1.25	0.196	0.208	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Kalmiopsis Wilderness	OR	4.54	3.90	3.83	3.45	3.46	3.32	3.20	3.20	3.29	3.56	4.39	4.32	0.053	0.044	1.32	0.206	0.219	0.009	0.120	0.100	3.00	0.470	0.500	0.020
Mount Hood	OR	4.29	3.81	3.46	3.87	2.95	3.15	2.85	3.00	3.10	3.86	4.53	4.55	0.053	0.044	1.33	0.209	0.222	0.009	0.120	0.100	3.00	0.470	0.500	0.020
Mount Jefferson	OR	4.41	3.90	3.56	3.74	3.07	3.11	2.89	2.91	3.03	3.78	4.55	4.54	0.054	0.045	1.34	0.210	0.223	0.009	0.120	0.100	3.00	0.470	0.500	0.020
Mountain Lakes	OR	4.29	3.62	3.32	2.98	2.86	2.64	2.49	2.50	2.64	3.10	4.12	4.26	0.051	0.043	1.28	0.201	0.214	0.009	0.120	0.100	3.00	0.470	0.500	0.020
MountWashington	OR	4.44	3.93	3.58	3.73	3.09	3.11	2.98	2.91	3.02	3.76	4.56	4.56	0.054	0.045	1.36	0.213	0.227	0.009	0.120	0.100	3.00	0.470	0.500	0.020
StrawberryMountain	OR	3.89	3.33	2.75	2.93	2.27	2.39	1.98	1.97	1.87	2.63	3.69	4.07	0.050	0.042	1.26	0.197	0.210	0.008	0.120	0.100	3.00	0.470	0.500	0.020
ThreeSisters	OR	4.47	3.95	3.61	3.72	3.11	3.11	3.00	2.91	3.03	3.79	4.60	4.57	0.054	0.045	1.35	0.212	0.226	0.009	0.120	0.100	3.00	0.470	0.500	0.020
AlpineLakes	WA	4.25	3.79	3.47	3.90	2.93	3.22	2.92	3.12	3.25	3.91	4.47	4.51	0.054	0.045	1.35	0.212	0.225	0.009	0.120	0.100	3.00	0.470	0.500	0.020
GlacierPeak	WA	4.16	3.72	3.42	3.75	2.91	3.16	2.88	3.14	3.33	3.90	4.42	4.43	0.054	0.045	1.34	0.210	0.223	0.009	0.120	0.100	3.00	0.470	0.500	0.020
GoatRocks	WA	4.25	3.75	3.36	4.24	2.83	3.38	3.03	3.19	3.07	3.77	4.42	4.55	0.054	0.045	1.34	0.210	0.224	0.009	0.120	0.100	3.00	0.470	0.500	0.020
Mount Adams	WA	4.29	3.80	3.44	4.40	2.92	3.49	3.12	3.27	3.13	3.86	4.49	4.56	0.053	0.044	1.33	0.209	0.222	0.009	0.120	0.100	3.00	0.470	0.500	0.020
MountRainier	WA	4.42	3.96	3.64	4.65	3.06	3.69	3.30	3.50	3.40	4.11	4.66	4.66	0.055	0.045	1.36	0.214	0.227	0.009	0.120	0.100	3.00	0.470	0.500	0.020
NorthCascades NP	WA	4.10	3.69	3.43	3.74	2.93	3.20	2.93	3.23	3.45	3.93	4.39	4.38	0.053	0.044	1.33	0.209	0.222	0.009	0.120	0.100	3.00	0.470	0.500	0.020
OlympicNP	WA	4.51	4.08	3.82	4.08	3.17	3.46	3.12	3.48	3.71	4.38	4.83	4.75	0.054	0.045	1.36	0.213	0.226	0.009	0.120	0.100	3.00	0.470	0.500	0.020
PasaytenWilderness	WA	4.17	3.72	3.41	3.72	2.89	3.16	2.88	3.15	3.32	3.86	4.42	4.46	0.053	0.044	1.33	0.208	0.222	0.009	0.120	0.100	3.00	0.470	0.500	0.020
BridgerWilderness	WY	2.52	2.35	2.34	2.19	2.10	1.80	1.50	1.49	1.74	2.00	2.44	2.42	0.046	0.038	1.14	0.178	0.190	0.008	0.120	0.100	3.00	0.470	0.500	0.020
FitzpatrickWilderness	WY	2.51	2.33	2.24	2.13	2.09	1.80	1.51	1.46	1.73	1.98	2.39	2.44	0.046	0.038	1.14	0.179	0.190	0.008	0.120	0.100	3.00	0.470	0.500	0.020
Grand Teton NP	WY	2.62	2.39	2.24	2.10	2.06	1.79	1.52	1.47	1.72	2.00	2.43	2.55	0.046	0.038	1.14	0.178	0.190	0.008	0.120	0.100	3.00	0.470	0.500	0.020
NorthAbsaroka	WY	2.43	2.27	2.24	2.17	2.14	1.93	1.69	1.56	1.76	2.04	2.35	2.40	0.046	0.038	1.14	0.178	0.190	0.008	0.120	0.100	3.00	0.470	0.500	0.020
TetonWilderness	WY	2.53	2.35	2.24	2.12	2.10	1.85	1.59	1.51	1.74	2.02	2.40	2.48	0.046	0.038	1.14	0.178	0.190	0.008	0.120	0.100	3.00	0.470	0.500	0.020
WashakieWilderness	WY	2.50	2.34	2.23	2.12	2.11	1.84	1.56	1.49	1.75	2.00	2.38	2.46	0.046	0.038	1.14	0.179	0.190	0.008	0.120	0.100	3.00	0.470	0.500	0.020
YellowstoneNP	WY	2.54	2.36	2.27	2.16	2.15	1.94	1.69	1.59	1.79	2.08	2.45	2.51	0.046	0.038	1.15	0.180	0.192	0.008	0.120	0.100	3.00	0.470	0.500	0.020

Appendix C

CALMET Protocol

(Draft)

To Be Posted on Idaho DEQ's

Regional Haze BART website

http://www.deq.idaho.gov/air/prog_issues/pollutants/haze_bart.cfm.

Appendix D

CALMET Parameter Values

Appendix A
CALMET Parameter Values

Recommended CALMET parameters chosen by the Region 10 states for use in BART modeling				
Input Group	Variable	Description	Default Value	Recommended Value
0	DIADAT	Input file: preprocessed surface temperature data (DIAG.DAT)	User Defined	
0	GEODAT	Input file: Geophysical data (GEO.DAT)	User Defined	User Define
0	LCFILES	Convert file name to lower case	User Defined	
0	METDAT	Output file (CALMET.DAT)	User Defined	
0	METLST	Output file (CALMET.LST)	User Defined	
0	MM4DAT	Input file: MM4 data (MM4.DAT)	User Defined	
0	NOWSTA	Input files: Names of NOWSTA overwater stations	User Defined	
0	NUSTA	Number of upper air data sites	User Defined	
0	PACDAT	Output file: in Mesopuff II format (PACOUT.DAT)	User Defined	
0	PRCDAT	Input file: Precipitation data (PRECIP.DAT)	User Defined	
0	PRGDAT	Input file: CSUMM prognostic wind data (PROG.DAT)	User Defined	
0	SEADAT	Input files: Names of NOWSTA overwater stations (SEAn.DAT)	User Defined	
0	SRFDAT	Input file: Surface data (SURF.DAT)	User Defined	
0	TSTFRD	Output file (TEST.FRD)	User Defined	
0	TSTKIN	Output file (TEST.KIN)	User Defined	
0	TSTOUT	Output file (TEST.OUT)	User Defined	
0	TSTPRT	Output file (TEST.PRT)	User Defined	
0	TSTSLP	Output file (TEST.SLP)	User Defined	
0	UPDAT	Input files: Names of NUSTA upper air data files (UPn.DAT)	UPn.DAT	
0	WTDAT	Input file: Terrain weighting factors (WT.DAT)	User Defined	
1	CLDDAT	Input file: Cloud data (CLOUD.DAT)	User Defined	Not used
1	IBDY	Beginning day	User Defined	
1	IBHR	Beginning hour	User Defined	
1	IBMO	Beginning month	User Defined	
1	IBTZ	Base time zone	User Defined	10
1	IBYR	Beginning year	User Defined	
1	IRLG	Number of hours to simulate	User Defined	User Define
1	IRTYPE	Output file type to create (must be 1 for CALPUFF)	1	1
1	ITEST	Flag to stop run after Setup Phase	User Defined	User Define
1	LCALGRD	Are w-components and temperature needed?	T	T
2	DATUM	WGS-G, NWS-27, NWS-84, ESR-S,…		NWS27
2	DGRIDKM	Grid spacing	User Defined	4
2	IUTMZN	UTM Zone	User Defined	User Define
2	LLCONF	When using Lambert Conformal map coordinates - rotate winds from true north to map north?	F	F
2	NX	Number of east-west grid cells	User Defined	User Define
2	NY	Number of north-south grid cells	User Defined	User Define
2	NZ	Number of vertical layers	User Defined	10
2	RLAT0	Latitude used if LLCONF = T	40	User Define
2	RLON0	Longitude used if LLCONF = T	90	User Define
2	XLAT0	Southwest grid cell latitude	User Defined	User Define
2	XLAT1	Latitude of 1st standard parallel	30	30
2	XLAT2	Latitude of 2nd standard parallel	60	60
2	XORIGKM	Southwest grid cell X coordinate	User Defined	User Define
2	YLON0	Southwest grid cell longitude	User Defined	User Define
2	YORIGKM	Southwest grid cell Y coordinate	User Defined	User Define
2	ZFACE	Vertical cell face heights (NZ+1 values)	User Defined	0,20,40,65,120,200,400, 700,1200,2200,4000
3	IFORMO	Format of unformatted file (1 for CALPUFF)	1	1
3	LSAVE	Save met. data fields in an unformatted file?	T	T
4	ICLOUD	Is cloud data to be input as gridded fields? (0 = No)	0	0

Recommended CALMET parameters chosen by the Region 10 states for use in BART modeling				
Input Group	Variable	Description	Default Value	Recommended Value
4	IFORMC	Format of cloud data (2 = formatted)	2	2
4	IFORMP	Format of precipitation data (2 = formatted)	2	2
4	IFORMS	Format of surface data (2 = formatted)	2	2
4	NOOBS	Use or non-use of surface, overwater, upper observations		1
4	NPSTA	Number of stations in PRECIP.DAT	User Defined	-1
4	NSSTA	Number of stations in SURF.DAT file	User Defined	User Define
5	ALPHA	Empirical factor triggering kinematic effects	0.1	0.1
5	BIAS	Surface/upper-air weighting factors (NZ values)	NZ*0	NZ*0
5	CRITFN	Critical Froude number	1	1
5	DIVLIM	Maximum acceptable divergence	5.00E-06	5.00E-06
5	FEXTR2	Multiplicative scaling factor for extrap surface obs to uppr layrs	NZ*0.0	
5	ICALM	Extrapolate surface calms to upper layers? (0 = No)	0	0
5	IDIOPT1	Compute temperatures from observations (0 = True)	0	0
5	IDIOPT2	Compute domain-average lapse rates? (0 = True)	0	0
5	IDIOPT3	Compute internally inital guess winds? (0 = True)	0	0
5	IDIOPT4	Read surface winds from SURF.DAT? (0 = True)	0	0
5	IDIOPT5	Read aloft winds from UPn.DAT? (0 = True)	0	0
5	IEXTRP	Extrapolate surface winds to upper layers? (-4 = use similarity theory and ignore layer 1 of upper air station data)	-4	-1
5	IFRADJ	Adjust winds using Froude number effects? (1 = Yes)	1	1
5	IKINE	Adjust winds using kinematic effects? (1 = Yes)	0	0
5	IOBR	Use O'Brien procedure for vertical winds? (0 = No)	0	0
5	IPROG	Using prognostic or MM-FDDA data? (0 = No)	0	14
5	ISLOPE	Compute slope flows? (1 = Yes)	1	1
5	ISTEPPG	Timestep (hours) of the prognostic model input data	1	1
5	ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	User Defined	User Defined
5	IUPT	Station for lapse rates (between 1 and NUSTA)	User Defined	User Defined
5	IUPWND	Upper air station for domain winds (-1 = 1/r**2 interpolation of all stations)	-1	-1
5	IWFCOD	Generate winds by diagnostic wind module? (1 = Yes)	1	1
5	KBAR	Level (1 to NZ) up to which barriers apply	NZ	
5	LLBREZE	Use Lake Breeze module	User Defined	F
5	LVARY	Use varying radius to develop surface winds?	F	F
5	METBXID	Station IDs in the region	User Defined	
5	NBAR	Number of Barriers to interpolation	User Defined	0
5	NBOX	Number of Lake Breeze regions	User Defined	
5	NINTR2	Max number of stations for interpolations (NA values)	99	99
5	NITER	Max number of passes in divergence minimization	50	50
5	NLB	Number of stations in region	User Defined	
5	NSMTH	Number of passes in smoothing (NZ values)	2, 4*(NZ-1)	12233444…
5	R1	Relative weight at surface of Step 1 field and obs	User Defined	1.00E-06
5	R2	Relative weight aloft of Step 1 field and obs	User Defined	1.00E-06
5	RMAX1	Max surface over-land extrapolation radius (km)	User Defined	200
5	RMAX2	Max aloft over-land extrapolation radius (km)	User Defined	200
5	RMAX3	Maximum over-water extrapolation radius (km)	User Defined	200
5	RMIN	Minimum extrapolation radius (km)	0.1	0.1
5	RMIN2	Distance (km) around an upper air site where vertical extrapolation is excluded (Set to -1 if IEXTRP = ±4)	4	-1
5	RPROG	Weighting factor for CSUMM prognostic wind data	User Defined	0
5	TERRAD	Radius of influence of terrain features (km)	User Defined	
5	XBBAR	X coordinate of Beginning of each barrier	User Defined	
5	XBCST	X Point defining the coastline (staight line)	User Defined	
5	XEBAR	X coordinate of Ending of each barrier	User Defined	
5	XECST	X Point	User Defined	

Recommended CALMET parameters chosen by the Region 10 states for use in BART modeling				
Input Group	**Variable**	**Description**	**Default Value**	**Recommended Value**
5	XG1	X Grid line 1 defining region of interest	User Defined	
5	XG2	X Grid line 2	User Defined	
5	YBBAR	Y coordinate of Beginning of each barrier	User Defined	
5	YBCST	Y Point	User Defined	
5	YEBAR	Y coordinate of Ending of each barrier	User Defined	
5	YECST	Y Point	User Defined	
5	YG1	Y Grid line 1	User Defined	
5	YG2	Y Grid Line 2	User Defined	
5	ZUPT	Depth of domain-average lapse rate (m)	200	200
5	ZUPWND	Bottom and top of layer for 1st guess winds (m)	1, 1000	1.,1000.
6	CONSTB	Neutral mixing height B constant	1.41	1.41
6	CONSTE	Convective mixing height E constant	0.15	0.15
6	CONSTN	Stable mixing height N constant	2400	2400
6	CONSTW	Over-water mixing height W constant	0.16	0.16
6	CUTP	Minimum cut off precip rate (mm/hr)	0.01	0.01
6	DPTMIN	Minimum capping potential temperature lapse rate	0.001	0.001
6	DZZI	Depth for computing capping lapse rate (m)	200	200
6	FCORIOL	Absolute value of Coriolis parameter	1.00E-04	1.00E-04
6	HAFANG	Half-angle for looking upwind (degrees)	30	30
6	IAVET	Conduct spatial averaging of temperature? (1 = True)	1	1
6	IAVEZI	Spatial averaging of mixing heights? (1 = True)	1	1
6	ILEVZI	Layer to use in upwind averaging (between 1 and NZ)	1	1
6	IRAD	Form of temperature interpolation (1 = 1/r)	1	1
6	ITPROG	3D temps from obs or from prognostic data?	0	2
6	JWAT1	Beginning landuse type defining water	999	55
6	JWAT2	Ending landuse type defining water	999	55
6	MNMDAV	Max averaging radius (number of grid cells)	1	1
6	NFLAGP	Method for precipitation interpolation (2 = 1/r**2)	2	2
6	NUMTS	Max number of stations in temperature interpolations	5	10
6	SIGMAP	Precip radius for interpolations (km)	100	36
6	TGDEFA	Default over-water capping lapse rate (K/m)	-0.0045	-0.0045
6	TGDEFB	Default over-water mixed layer lapse rate (K/m)	-0.0098	-0.0098
6	TRADKM	Radius of temperature interpolation (km)	500	500
6	ZIMAX	Maximum over-land mixing height (m)	3000	3000
6	ZIMAXW	Maximum over-water mixing heigh (m)	3000	3000
6	ZIMIN	Minimum over-land mixing height (m)	50	50
6	ZIMINW	Minimum over-water mixing height (m)	50	50

Appendix E

CALPUFF Parameter Values

Appendix E
CALPUFF Parameter Values

Recommended CALPUFF parameters chosen by the EPA Region 10 states for use in BART modeling.						
Input Group	Group Description	Sequence	Variable	Description	Default Value	Recommended Value
1	Run Control	1	METRUN	Do we run all periods (1) or a subset (0)?	0	
1		2	IBYR	Beginning year	User Defined	
1		3	IBMO	Beginning month	User Defined	
1		4	IBDY	Beginning day	User Defined	
1		5	IBHR	Beginning hour	User Defined	
1		5	IRLG	Length of run (hours)	User Defined	
1		6	NSPEC	Number of species modeled (for MESOPUFF II chemistry)	5	
1		7	NSE	Number of species emitted	3	
1		8	ITEST	Flag to stop run after Setup Phase	2	
1		9	MRESTART	Restart options (0 = no restart) allows splitting runs into smaller segments	0	
1		10	NRESPD	Number of periods in Restart	0	
1		11	METFM	Format of input meteorology (1 = CALMET, 2 = ISC)	1	
1		12	AVET	Averaging time lateral dispersion parameters (minutes)	60	60
1		13	PGTIME	PG Averaging time	60	60
2	Tech Options	1	MGAUSS	Near-field vertical distribution (1 = Gaussian)	1	1
2		2	MCTADJ	Terrain adjustments to plume path (3 = Plume path)	3	3
2		3	MCTSG	Do we have subgrid hills? (0 = No) allows CTDM-like treatment for subgrid scale hills	0	0
2		4	MSLUG	Near-field puff treatment (0 = No slugs)	0	0
2		5	MTRANS	Model transitional plume rise? (1 = Yes)	1	1
2		6	MTIP	Treat stack tip downwash? (1 = Yes)	1	1
2		7	MBDW	Method to simulate downwash (1=ISC,2=PRIME)		not used
2		8	MSHEAR	Treat vertical wind shear? (0 = No)	0	0
2		9	MSPLIT	Allow puffs to split? (0 = No)	0	0
2		10	MCHEM	MESOPUFF-II Chemistry? (1 = Yes)	1	1
2		11	MAQCHEM	Aqueous phase transformation	0	0
2		12	MWET	Model wet deposition? (1 = Yes)	1	1
2		13	MDRY	Model dry deposition? (1 = Yes)	1	1
2		14	MDISP	Method for dispersion coefficients (2=micromet,3 = PG)	3	3
2		15	MTURBVW	Turbulence characterization? (Only if MDISP = 1 or 5)	3	3
2		16	MDISP2	Backup coefficients (Only if MDISP = 1 or 5)	3	3
2		17	MROUGH	Adjust PG for surface roughness? (0 = No)	0	0
2		18	MPARTL	Model partial plume penetration? (0 = No)	1	1
2		19	MTINV	Elevated inversion strength (0 = compute from data)	0	0
2		20	MPDF	Use PDF for convective dispersion? (0 = No)	0	0
2		21	MSGTIBL	Use TIBL module? (0 = No) allows treatment of subgrid scale coastal areas	0	0
2		22	MBCON	Boundary conditions modeled	0	0
2		23	MFOG	Configure for FOG model output	0	0
2		24	MREG	Regulatory default checks? (1 = Yes)	1	1
3	Species List	1	CSPECn	Names of species modeled (for MESOPUFF II must be SO2-SO4-NOX-HNO3-NO3)	User Defined	
3		2	Specie Names	Manner species will be modeled	User Defined	
3		3	Specie Groups	Grouping of species if any	User Defined	
3		4	CGRUP			
3		5	CGRUP			

Recommended CALPUFF parameters chosen by the EPA Region 10 states for use in BART modeling.						
Input Group	Group Description	Sequence	Variable	Description	Default Value	Recommended Value
4	Grid Control	1	NX	Number of east-west grids of input meteorology	User Defined	
4		2	NY	Number of north-south grids of input meteorology	User Defined	
4		3	NZ	Number of vertical layers of input meteorology	User Defined	
4		4	DGRIDKM	Meteorology grid spacing (km)	User Defined	
4		5	ZFACE	Vertical cell face heights of input meteorology	User Defined	
4		6	XORIGKM	Southwest corner (east-west) of input User	Defined meteorology	
4		7	YORIGIM	Southwest corner (north-south) of input User	Defined meteorology	
4		8	IUTMZN	UTM zone	User Defined	
4		9	XLAT	Latitude of center of meteorology domain	User Defined	
4		10	XLONG	Longitude of center of meteorology domain	User Defined	
4		11	XTZ	Base time zone of input meteorology	User Defined	
4		12	IBCOMP	Southwest X-index of computational domain	User Defined	
4		13	JBCOMP	Southwest Y-index of computational domain	User Defined	
4		14	IECOMP	Northeast X-index of computational domain	User Defined	
4		15	JECOMP	Northeast Y-index of computational domain	User Defined	
4		16	LSAMP	Use gridded receptors? (T = Yes)	F	
4		17	IBSAMP	Southwest X-index of receptor grid	User Defined	
4		18	JBSAMP	Southwest Y-index of receptor grid	User Defined	
4		19	IESAMP	Northeast X-index of receptor grid	User Defined	
4		20	JESAMP	Northeast Y-index of receptor grid	User Defined	
4		21	MESHDN	Gridded recpetor spacing = DGRIDKM/MESHDN	1	
4			XLAT1	Latitude of 1st standard parallel		
4			XLAT2	Latitude of 2nd standard parallel		
4			DATUM			WGS-84
5	Output Options	1	ICON	Output concentrations? (1 = Yes)	1	1
5		2	IDRY	Output dry deposition flux? (1 = Yes)	1	1
5		3	IWET	Output west deposition flux? (1 = Yes)	1	1
5		4	IT2D	2D Temperature	0	0
5		5	IRHO	2D Density	0	0
5		6	IVIS	Output RH for visibility calculations (1 = Yes)	1	1
5		7	LCOMPRS	Use compression option in output? (T = Yes)	T	T
5		8	ICPRT	Print concentrations? (0 = No)	0	0
5		9	IDPRT	Print dry deposition fluxes (0 = No)	0	0
5		10	IWPRT	Print wet deposition fluxes (0 = No)	0	0
5		11	ICFRQ	Concentration print interval (1 = hourly)	1	24
5		12	IDFRQ	Dry deposition flux print interval (1 = hourly)	1	24
5		13	IWFRQ	West deposition flux print interval (1 = hourly)	1	24
5		14	IPRTU	Print output units (1 = g/m**3; g/m**2/s; 3 = ug/m3, ug/m2/s)	1	3
5		15	IMESG	Status messages to screen? (1 = Yes)	1	2
5		16	LDEBUG	Turn on debug tracking? (F = No)	F	F
5		17	NPFDEB	(Number of puffs to track)	(1)	1
5		18	NN1	(Met. Period to start output)	(1)	1
5		19	NN2	(Met. Period to end output)	(10)	10
7	Dry Dep Chem		Dry Gas Dep	Chemical parameters of gaseous deposition species	User Defined	defaults
8	Dry Dep Size		Dry Part. Dep	Chemical parameters of particulate deposition species	User Defined	defaults
9	Dry Dep Misc	1	RCUTR	Reference cuticle resistance (s/cm)	30	30
9		2	RGR	Reference ground resistance (s/cm)	10	10
9		3	REACTR	Reference reactivity	8	8
9		4	NINT	Number of particle-size intervals	9	9
9		5	IVEG	Vegetative state (1 = active and unstressed; 2=active and stressed)	1	1

Recommended CALPUFF parameters chosen by the EPA Region 10 states for use in BART modeling.						
Input Group	**Group Description**	**Sequence**	**Variable**	**Description**	**Default Value**	**Recommended Value**
10	Wet Dep		Wet Dep	Wet deposition parameters	User Defined	defaults
11	Chemistry	1	MOZ	Ozone background? (0 = constant background value; 1 = read from ozone.dat)	0	0
11		2	BCKO3	Ozone default (ppb) (Use only for missing data)	80	40 and 80
11		3	BCKNH3	Ammonia background (ppb)	10	17
11		4	RNITE1	Nighttime SO2 loss rate (%/hr)	0.2	0.2
11		5	RNITE2	Nighttime NOx loss rate (%/hr)	2	2
11		6	RNITE3	Nighttime HNO3 loss rate (%/hr)	2	2
11		7	MH2O2	H2O2 data input option	1	1
11		8	BCKH2O2	Monthly H2O2 concentrations	1	12*1
			BKPMF	Fine particulate concentration	12 * 1.00	not used
			OFRAC	Organic fraction of Fine Particulate	2*0.15, 9*0.20, 1*0.15	not used
			VCNX	VOC / NOX ratio	12 * 50.00	not used
12	Dispersion	1	SYTDEP	Horizontal size (m) to switch to time dependence	550	550
12		2	MHFTSZ	Use Heffter for vertical dispersion? (0 = No)	0	0
12		3	JSUP	PG Stability class above mixed layer	5	5
12		4	CONK1	Stable dispersion constant (Eq 2.7-3)	0.01	0.01
12		5	CONK2	Neutral dispersion constant (Eq 2.7-4)	0.1	0.1
12		6	TBD	Transition for downwash algorithms (0.5 = ISC)	0.5	0.5
12		7	IURB1	Beginning urban landuse type	10	10
12		8	IURB2	Ending urban landuse type	19	19
12		9	ILANDUIN	Land use type (20 = Unirrigated agricultural land)	20	20
12		10	ZOIN	Roughness length (m)	0.25	0.25
12		11	XLAIIN	Leaf area index	3.0	3.0
12		12	ELEVIN	Met. Station elevation (m above MSL)	0.0	0.0
12		13	XLATIN	Met. Station North latitude (degrees)	-999.0	-999.0
12		14	XLONIN	Met. Station West longitude (degrees)	-999.0	-999.0
12		15	ANEMHT	Anemometer height of ISC meteorological data (m)	10.0	10.0
12		16	ISIGMAV	Lateral turbulence (Not used with ISC meteorology)	1	1
12		17	IMIXCTDM	Mixing heights (Not used with ISC meteorology)	0	0
12		18	XMXLEN	Maximum slug length in units of DGRIDKM	1.0	1
12		19	XSAMLEN	Maximum puff travel distance per sampling step (units of DGRIDKM)	1.0	1
12		20	MXNEW	Maximum number of puffs per hour	99	99
12		21	MXSAM	Maximum sampling steps per hour	99	99
12		22	NCOUNT	Iterations when computing Transport Wind (Calmet & Profile Winds)	2	2
12		23	SYMIN	Minimum lateral dispersion of new puff (m)	1.0	1
12		24	SZMIN	Minimum vertical dispersion of new puff (m)	1.0	1
12		25	SVMIN	Array of minimum lateral turbulence (m/s)	6 * 0.50	6 * 0.50
12		26	SWMIN	Array of minimum vertical turbulence (m/s)	0.20,0.12,0.08, 0.06,0.03,0.016	
12		27	CDIV (1), (2)	Divergence criterion for dw/dz (1/s)	0.01 (0.0,0.0)	0.0,0.0
12		28	WSCALM	Minimum non-calm wind speed (m/s)	0.5	0.5
12		29	XMAXZI	Maximum mixing height (m)	3000	3000
12		30	XMINZI	Minimum mixing height (m)	50	50
12		31	WSCAT	Upper bounds 1st 5 wind speed classes (m/s)	1.54,3.09,5.14, 8. 23,10.8	1.54,3.09,5.14, 8. 23,10.8
12		32	PLX0	Wind speed power-law exponents	0.07,0.07,0.10, 0.15,0.35,0.55	0.07,0.07,0.10, 0.15,0.35,0.55
12		33	PTGO	Potential temperature gradients PG E and F (deg/km)	0.020,0.035	0.020,0.035
12		34	PPC	Plume path coefficients (only if MCTADJ = 3)	0.5,0.5,0.5, 0.5,0.35,0.35	0.5,0.5,0.5, 0.5,0.35,0.35
12		35	SL2PF	Maximum Sy/puff length	10.0	10.0
12		36	NSPLIT	Number of puffs when puffs split	3	3

Recommended CALPUFF parameters chosen by the EPA Region 10 states for use in BART modeling.						
Input Group	**Group Description**	**Sequence**	**Variable**	**Description**	**Default Value**	**Recommended Value**
12		37	IRESPLIT	Hours when puff are eligible to split	User Defined	
12		38	ZISPLIT	Previous hour's mixing height(minimum)(m)	100.0	100.0
12		39	ROLDMAX	Previous Max mix ht/current mix ht ratio must be less then this value for puff to split	0.25	0.25
12		40	NSPLITH	Number of puffs when puffs split horizontally	5	5
12		41	SYSPLITH	Min sigma-y (grid cell units) of puff before horiz split	1.0	1.0
12	12	42	SHSPLITH	Min puff elongation rate per hr from wind shear before horiz split	2.0	2.0
12		43	CNSPLITH	Min conc g/m3 before puff may split horizontally	1.0E-07	1.0E-07
12		44	EPSSLUG	Convergence criterion for slug sampling integration	1.00E-04	1.00E-04
12		45	EPSAREA	Convergence criterion for area source integration	1.00E-06	1.00E-06
12		46	DSRISE	Step length for rise integration	1.0	1.0
12		47	HTMINBC		500.0	500.0
12		48	RSAMPBC		10.0	10.0
12		49	MDEPBC		1	1
13	Point Source	1	NPT1	Number of point sources	User Defined	
13		2	IPTU	Units of emission rates (1 = g/s)	1	
13		3	NSPT1	Number of point source-species combinations	0	
13		4	NPT2	Number of point sources with fully variable emission rates	0	
13			Point Sources	Point sources characteristics	User Defined	
14	Area Source		Area Sources	Area sources characteristics	User Defined	
15	Volume Source		Volume	Volume sources characteristics	User Defined Sources	
16	Line Source		Line Sources	Buoyant lines source characteristics	User Defined	
17	Receptors		NREC	Number of user defined receptors	User Defined	
17			Receptor Data	Location and elevation (MSL) of receptors	User Defined	

Appendix F

CALPOST Parameter Values

Appendix F
CALPOST Parameter Values

Calpost Input Parameters					
Input Group	**Sequence**	**Variable**	**Description**	**Default**	**Value**
1		ASPEC	Species to process	VISIB	VISIB
1		ILAYER	Layer/deposition code (1 = CALPUFF concentrations; -3 = wet+dry deposition fluxes)	1	1
1		LBACK	Add Hourly Background Concentrations/Fluxes?	F	F
2		RHMAX	Maximum relative humidity (%) used in particle growth curve	98	95
2		LDRING	Report results by Discrete receptor Ring, if Discrete Receptors used. (T = true)	T	
			Modeled species to be included in computing the light extinction		
2		LVSO4	Include SO4?	T	T
2		LVNO3	Include NO3?	T	T
2		LVOC	Include Organic Carbon?	T	T
2		LVPMC	Include Coarse Particles?	T	T
2		LVPMF	Include Fine Particles?	T	T
2		LVEC	Include Elemental Carbon?	T	T
2		LVBK	when ranking for TOP-N, TOP-50, and Exceedance tables Include BACKGROUND?	T	T
2		SPECPMC	Species name used for particulates in MODEL.DAT file: COARSE =	PMC	PMC
2		SPECPMF	Species name used for particulates in MODEL.DAT file: FINE =	PMF	PMF
			Extinction Efficiencies (1/Mm per ug/m**3)		
2		EEPMC	PM COARSE =	0.6	0.6
2		EEPMF	PM FINE =	1.0	1.0
2		EEPMCBK	Background PM COARSE	0.6	0.6
2		EESO4	SO4 =	3.0	3.0
2		EENO3	NO3 =	3.0	3.0
2		EEOC	Organic Carbon =	4.0	4.0
2		EESOIL	Soil =	1.0	1.0
2		EEEC	Elemental Carbon =	10.0	10.0
2		MVISBK	Method used for background light extinction (2 = Hourly RH adjustment; 6 = FLAG seasonal f(RH))	2 or 6	6
2		RHFAC	Monthly RH adjustment factors from FLAG (unique for each Class I area)	Yes if 6	EPA
			Background monthly extinction coefficients (FLAG) unique for each Class I area		
2		BKSO4	Assume all hygroscopic species as SO4 (raw extinction value without scattering efficiency adjustment)		*see table*
2		BKNO3			*see table*
2		BKPMC			*see table*
2		BKOC			*see table*
2		BKSOIL	Assume all non-hygroscopic species as Soil		*see table*
2		BKEC			*see table*
2		BEXTRAY	Extinction due to Rayleigh scattering	10.0	10.0
			Averaging time(s) reported		
3		L1HR	1-hr averages	F	F
3		L3HR	3-hr averages	F	F
3		L24HR	24-hr averages	T	T
3		LRUNL	Run lengtyh (annual)	F	F
3		LT50	Top 50 table for each averaging time selected	T	F
3		LTOPN			1
3		NTOP			1

Appendix G

CALPOST PM Speciation

from the

National Park Service

and the

U.S. Forest Service

Appendix G
CALPOST PM Speciation

The National Park Service and the U.S. Forest Service have recommended values for use in CALPOST for PM speciation. Below is an email from Don Shepherd of the National Park Service to several U.S. Forest Service staff. The email refers to several MS Excel spreadsheets, which are too extensive to include in the protocol. Instead, all the spreadsheets are located on the Idaho Department of Environmental Quality's Regional Haze website, http://www.deq.idaho.gov/air/prog_issues/pollutants/haze_bart.cfm.
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From: ALLEN Philip
Sent: Wednesday, March 15, 2006 12:01 PM
To: ALLEN Philip
Subject: RE: FW: PM Speciation

-----Original Message-----
From: Don_Shepherd@nps.gov [mailto:Don_Shepherd@nps.gov]
Sent: Tuesday, November 22, 2005 10:08 AM
To: Kiss,Michael
Cc: astacy@fs.fed.us; CHRIS ARRINGTON; chuber@fs.fed.us; Don_Shepherd@nps.gov; HGebhart@air-resource.com; itombach; Joelle Burleson; John_Notar@nps.gov; Joe Scire; Bacon, Leigh; Pat Brewer; Rosalina Rodriguez; Sheila Holman; Tim_Allen@partner.nps.gov; Rogers, Tom; wentworth.paul@epa.gov; little.james@epa.gov; twickman@fs.fed.us; Golden.Kevin@epamail.epa.gov; baker.robert@epa.gov; Wong.Herman@epamail.epa.gov; jslade@state.pa.us; richard.cordes@pca.state.mn.us; tbachman@state.nd.us; Kyrik.Rombough@state.sd.us; dwalsh@state.mt.us; Rchea@smtpgate.dphe.state.co.us; MilkaR@utah.gov; Uhl, Mary, NMENV; massey.eric@azdeq.gov; pabuonviri@deq.state.va.us; grfeagins@deq.state.va.us; pcummins@westgov.org; lalter@westgov.org
Subject: RE: PM Speciation

Mike & Co:

As a follow-up to my "threat" to send more speciation data, here is my best first shot at PM speciation for cement kilns,

(See attached file: DLS PM Speciation for Cement kilns.doc)(See attached file: DLS Wet Cement Kiln w FF Speciation.xls)(See attached file: DLS Dry Cement Kiln w ESP Speciation.xls)(See attached file: DLS Dry Cement Kiln w FF Speciation.xls)(See attached file: DLS Wet Cement Kiln w ESP Speciation.xls)

lime kilns,

(See attached file: PM Speciation for Lime Kilns.doc)(See attached file: Rotary Lime Kiln w FF Speciation.xls)(See attached file: Rotary Lime Kiln w Scrubber Speciation.xls)(See attached file: Rotary Lime Kiln w ESP Speciation.xls)(See attached file: Calcimatic Lime Kiln w Scrubber Speciation.xls)

and coal dryers.

(See attached file: DLS PM Speciation for Thermal Dryers.doc)(See attached file: Fluidized Bed Dryer w Scrubber Speciation.xls)

As before, this is based on a lot of guesswork and assumptions that are, in turn, based on emission factors with some really lousy ratings, so take it with many grains of salt. And, of course, comments are welcome...

(For those of you who did not get the first batch, at the request of VISTAS and VADEQ, i generated PM10 speciation profiles for several flavors of coal- and oil-fired boilers--let me know if you want any of that.)

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Air Resources Division
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